

WHAT IS CLAIMED IS:

1 1. A surgical clip for sealingly joining a graft vessel to a target vessel, the
2 graft vessel having a graft vessel wall defining a graft lumen, the target vessel having
3 a target vessel wall defining a target lumen, the surgical clip comprising:
4 a clip body;

5 a needle portion extending from the clip body and having a distal end
6 configured to penetrate the graft and target vessel walls and extend outside of the graft
7 and target vessels, the clip body being configured to prevent passage of the clip body
8 through the graft and target vessel walls; and

9 a retainer disposed outside of the graft and target vessels for retaining the graft
10 and target vessel walls on the needle portion.

1 2. The surgical clip of claim 1 wherein the retainer comprises a leg
2 attached to the clip body movable between an open position spaced apart from the
3 needle portion and a closed position closer to the needle portion for retaining the graft
4 and target vessel walls thereon.

1 3. The surgical clip of claim 2 wherein the retainer is configured to
2 compress the graft vessel wall against the target vessel wall.

1 4. The surgical clip of claim 3 wherein the retainer has an inner surface
2 and the clip body has an outer surface which faces the inner surface in the closed
3 position, the retainer being configured to compress the graft and target vessel walls
4 between the inner and outer surfaces.

1 5. The surgical clip of claim 4 wherein the needle portion is disposed at a
2 an angle of no more than about 120° relative to the outer surface of the clip body in
3 the open position.

1 6. The surgical clip of claim 2 wherein an end portion of the retainer is
2 configured to extend across the needle portion in the closed position.

- 1 7. The surgical clip of claim 6 wherein the retainer has two generally
 - 2 parallel segments for extending across the needle portion on opposing sides thereof
 - 3 and a slot between the parallel segments for receiving the needle portion.
- 1 8. The surgical clip of claim 1 wherein the retainer comprises at least one
 - 2 barb on the needle portion.
- 1 9. The surgical clip of claim 1 wherein the needle portion is hook-shaped.
- 1 10. The surgical clip of claim 2 wherein the retainer shields the distal end
 - 2 of the needle portion in the closed position.
- 1 11. The surgical clip of claim 2 wherein the retainer contacts the needle
 - 2 portion in the closed position.
- 1 12. The surgical clip of claim 1 wherein the clip body includes a middle
 - 2 portion configured to be held by a clip applier for applying the clip.
- 1 13. The surgical clip of claim 2 wherein the middle portion has a
 - 2 substantially larger cross-sectional area than the needle portion.
- 1 14. The surgical clip of claim 12 wherein the middle portion has an
 - 2 aperture therein for receiving a portion of the clip applier.
- 1 15. The surgical clip of claim 1 wherein the clip body includes a coupling
 - 2 for attachment to a flexible band.
- 1 16. The surgical clip of claim 1 wherein the needle portion has a length of
 - 2 at least about twice the combined thickness of the graft and target vessel walls.
- 1 17. An anastomosis device for sealingly joining a graft vessel to a target
 - 2 vessel, the graft vessel having a free end and a graft vessel wall defining a graft

3 lumen, the target vessel having a target vessel wall with an opening therein and
4 defining a target lumen, the anastomosis device comprising:
5 a flexible ring-shaped band defining a central opening in which the graft vessel
6 may be received; and
7 a plurality of clips coupled to the band and positionable at spaced apart
8 locations around the band, each clip having a first portion for engaging the graft vessel
9 wall and a second portion for engaging the target vessel wall, the first and second
10 portions being configured to retain the graft vessel wall in sealing engagement with
11 the target vessel wall.

1 18. The anastomosis device of claim 17 wherein the clip has a distal
2 extremity for penetrating the graft and target vessel walls.

1 19. The anastomosis device of claim 18 wherein the clip is generally hook-
2 shaped, the distal extremity being oriented at an angle of at least about 90° relative to
3 a proximal portion of the clip.

1 20. The anastomosis device of claim 17 wherein the clip has a loop for
2 slidably receiving the band.

1 21. The anastomosis device of claim 18 wherein at least a portion of the
2 clip is movable between an open and a closed position so as to retain the graft and
3 target vessel walls on the distal extremity.

1 22. The anastomosis device of claim 21 wherein the movable portion of
2 the clip is configured to remain outside of the graft and target vessels when the distal
3 extremity has penetrated the graft and target vessel walls.

1 23. The anastomosis device of claim 22 wherein the distal extremity has a
2 distal end, the distal end being configured to be disposed outside the graft and target
3 vessels when the distal extremity has penetrated the graft and target vessel walls.

1 24. The anastomosis device of claim 21 wherein the movable portion of
2 the clip is deformable from the open position to the closed position.

1 25. The anastomosis device of claim 21 wherein the movable portion is
2 spaced apart from the distal extremity in the open position and is closer to the distal
3 extremity in the closed position.

1 26. The anastomosis device of claim 21 wherein the distal extremity is
2 movable between the open and closed positions.

1 27. The anastomosis device of claim 18 further comprising a retainer for
2 retaining the graft and target vessel walls on the distal extremity.

1 28. The anastomosis device of claim 27 wherein the retainer comprises at
2 least one barb on the distal extremity.

1 29. An anastomosis system for sealingly joining a graft vessel to a target
2 vessel, the graft vessel having a free end and a graft vessel wall defining a graft
3 lumen, the target vessel having a target vessel wall with an opening therein and
4 defining a target lumen, the anastomosis system comprising:
5 at least one anastomosis clip including a clip body having a distal extremity
6 with a distal end and a proximal extremity with a proximal end, the distal end being
7 configured to penetrate through the graft and target vessel walls; and

8 a clip applier including a holding mechanism for releasably holding the
9 anastomosis clip such that the distal end may be passed through the graft vessel wall
10 near the free end and through the target vessel wall near the opening such that both the
11 distal and proximal ends of the clip body are outside the graft and target vessels, and a
12 shaping mechanism disposed outside the graft and target vessels for shaping at least a
13 portion of the clip body so as to compress the graft wall against the target vessel wall
14 with the target vessel lumen in communication with the graft vessel lumen.

1 30. The anastomosis system of claim 29 wherein the proximal extremity
2 comprises a leg extending from the clip body movable between an open position

3 spaced apart from the distal extremity and a closed position closer to the distal
4 extremity.

1 31. The anastomosis system of claim 30 wherein the proximal extremity
2 shields the distal end of the distal extremity in the closed position.

1 32. The anastomosis system of claim 29 wherein the distal extremity is
2 movable from an open position spaced apart from the proximal extremity and a closed
3 position closer to the proximal extremity.

1 33. The anastomosis system of claim 32 wherein the distal extremity has
2 an inner surface and the clip body has an outer surface which faces the inner surface in
3 the closed position, the distal extremity being configured to compress the graft and
4 target vessel walls between the inner and outer surfaces in the closed position.

1 34. The anastomosis system of claim 33 wherein the inner surface of the
2 distal extremity is disposed at an angle of no more than about 120° relative to the
3 outer surface of the clip body in the open position.

1 35. The anastomosis system of claim 29 wherein the clip body includes a
2 middle portion configured to be held by the clip applier.

1 36. The anastomosis system of claim 35 wherein the middle portion has a
2 substantially larger cross-sectional area than the distal extremity.

1 37. The anastomosis system of claim 36 wherein the clip applier has a pin
2 on a distal end thereof and wherein the middle portion of the clip body has an aperture
3 therein for receiving the pin.

1 38. The anastomosis system of claim 35 wherein the holding mechanism is
2 configured to hold the middle portion in a stationary position relative to the clip
3 applier as the shaping mechanism shapes the clip body.

1 39. The anastomosis system of claim 29 wherein the clip applier is
2 configured to hold a plurality of clips.

1 40. The anastomosis system of claim 39 wherein the clip applier has an
2 axial channel and the clip has a middle portion having a width wider than the distal
3 extremity, the middle portion being configured to be axially slidale along the axial
4 channel.

1 41. The anastomosis clip of claim 29 wherein the clip applier has an inner
2 shaft and an outer shaft movable with respect to each other, the clip body being held
3 by a first of either the inner or the outer shaft and the clip body being shaped by a
4 second of either the inner or the outer shaft.

1 42. A method of sealingly joining a graft vessel to a target vessel, the graft
2 vessel having a free end and a graft vessel wall defining a graft lumen, the target
3 vessel having a target vessel wall defining a target lumen and having an opening
4 therein, the method comprising:

5 providing a plurality of anastomosis clips each including a clip body having a
6 distal extremity with a distal end and a proximal extremity with a proximal end;

7 penetrating the graft vessel wall and the target vessel wall with the distal
8 extremity of each anastomosis clip such that the distal and proximal ends are disposed
9 outside of the graft and target vessels; and

10 shaping a portion of each clip body outside of the graft and target vessels so as
11 to compress the graft vessel wall against the target vessel wall with the graft lumen in
12 communication with the target lumen.

1 43. The method of claim 42 wherein the shaping step comprises moving
2 the proximal extremity of the clip body from an open position spaced apart from the
3 distal extremity to a closed position closer to the distal extremity.

1 44. The method of claim 42 wherein the shaping step comprises moving
2 the distal extremity of the clip body from an open position spaced apart from the distal
3 extremity to a closed position closer to the distal extremity.

1 45. The method of claim 42 wherein the shaping step comprises generally
2 inelastically deforming a portion of the clip body.

1 46. The method of claim 42 wherein the shaping step comprises
2 compressing the graft and target vessel walls between an inner surface of the distal
3 extremity and an outer surface of the proximal extremity.

1 47. The method of claim 42 further comprising shielding the distal end of
2 the distal extremity outside the graft and target vessels after penetrating the graft and
3 target vessel walls.

1 48. The method of claim 42 wherein the target vessel comprises a coronary
2 artery on the heart.

1 49. The method of claim 48 wherein the graft vessel comprises a vessel
2 selected from the group including mammary arteries, vein grafts, arterial grafts, and
3 artificial grafts.

1 50. The method of claim 42 wherein the step of penetrating comprises,
2 after penetrating the graft vessel wall, selecting a position for penetrating the target
3 vessel wall, and positioning the distal extremity relative to the target vessel wall so as
4 to penetrate the target vessel wall at said position.

1 51. The method of claim 42 wherein the step of penetrating is performed
2 without continually maintaining the graft vessel wall in contact with the target vessel
3 wall.

1 52. The method of claim 51 further comprising positioning the graft vessel
2 wall relative to the target vessel wall after penetrating the graft vessel wall but before
3 penetrating the target vessel wall.

1 53. The method of claim 52 wherein the target vessel is in a body cavity,
2 the step of penetrating comprising penetrating the graft vessel wall outside the body
3 cavity, positioning the graft vessel in the body cavity, and penetrating the target vessel
4 wall in the body cavity.

1 54. The method of claim 52 wherein the target vessel is in a body cavity,
2 the step of shaping being performed with an elongated instrument positioned in the
3 body cavity through a percutaneous penetration.

1 55. The method of claim 54 wherein the elongated instrument is positioned
2 through a tubular cannula into the body cavity.

1 56. The method of claim 54 wherein the elongated instrument comprises a
2 clip applier.

1 57. The method of claim 56 further comprising repeating the steps of
2 penetrating and shaping for a plurality of anastomosis clips without removing the clip
3 applier from the body cavity.